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Yields With and Without Repeated Commercial Thinnings in a High-site-quality Douglas-fir Stand

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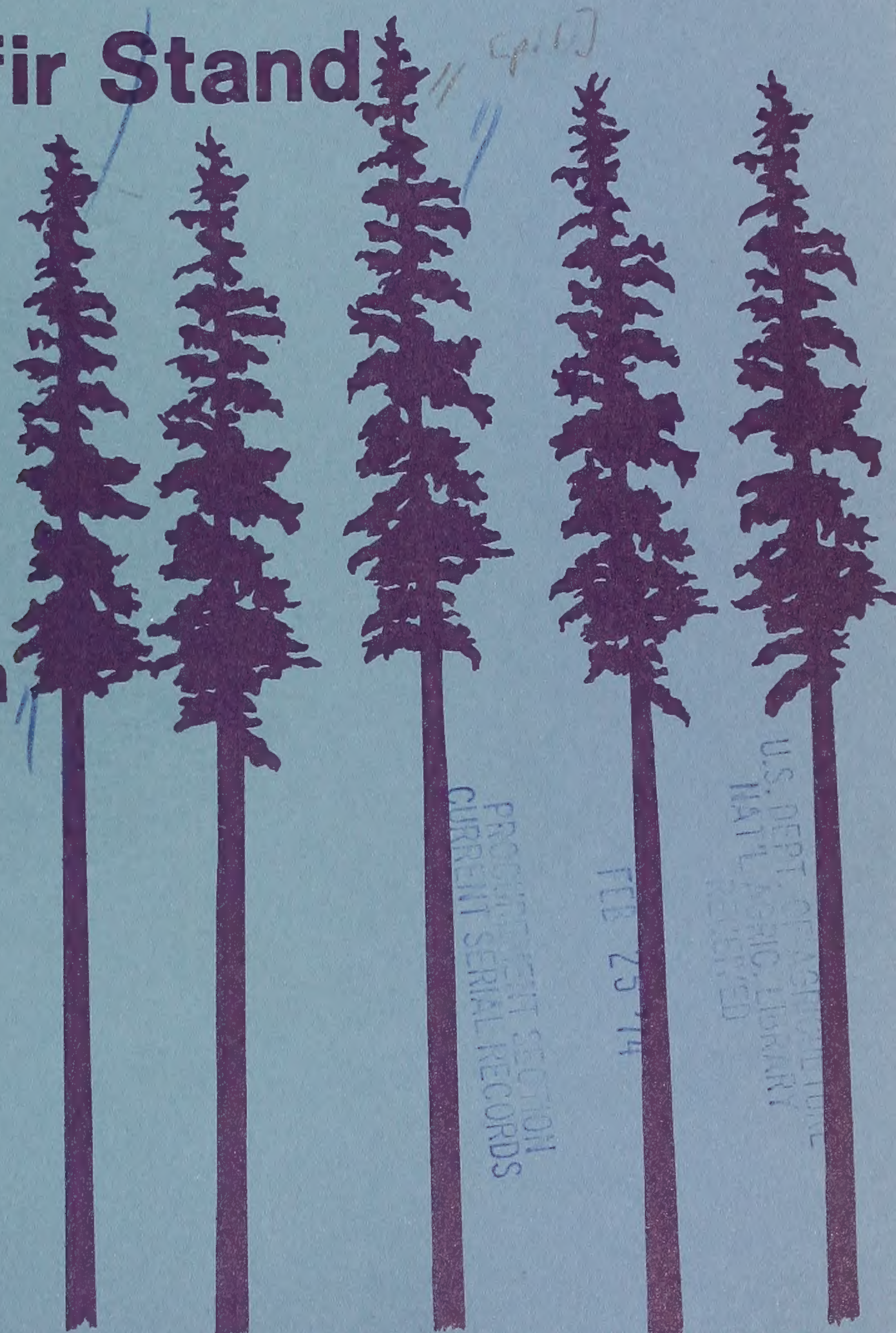

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
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ABSTRACT

A high-site-quality Douglas-fir stand was first thinned when about 57 years old and at 5-year intervals thereafter through approximately age 72. Before the stand was first thinned, it had about 150 stems per acre, with a mean d.b.h. of 17 inches. The thinnings evidently caused about a 10-percent reduction in gross growth per acre. On the other hand, 15-year diameter growth of surviving trees was 29 percent greater in thinned than in unthinned stands. The reduction in gross growth was more than offset by forestalling and salvaging mortality. As a result, if the final harvest is made 10 years after the last thinning, at about age 82, thinnings will have brought about an estimated 5-percent increase in total usable production. It should be recognized that removal of volume in these thinnings will have resulted in about a 20-percent reduction in volume to be cut at that final harvest. If final harvest is delayed longer, the difference in available volume in thinned and unthinned stands will lessen somewhat, primarily because of greater mortality in the unthinned stand.

Keywords: Douglas-fir, thinning (trees), forest yield, diameter increment, stand volume increment, mortality, merchantable volume.

Land managers have expressed considerable interest in gains to be achieved by thinning stands of trees. Many are interested not only in what can be gained by thinning at very young ages but also in what is gained if thinnings are delayed beyond the optimum initial entry time. This paper reports some consequences of making delayed, light, frequent thinnings in a high-site-quality stand of nearly pure Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco).

METHODS

LOCATION AND LAYOUT OF STUDY

In 1949, the McCleary Experimental Forest[1/] was established near the town of McCleary, in Grays Harbor County, Washington, for the purpose of conducting studies and demonstrations in management of young-growth forests. Results presented herein are derived from 1/5-acre plots which sample about 125 acres[2/]--95 thinned and 30 unthinned. Sixteen plots were clustered quite tightly within the unthinned portions of the stand, whereas 18 plots were scattered over the thinned portions. The area designated for thinning was divided into five subareas, each of which was thinned in successive years on a 5-year-cycle. Each subarea was sampled by one to six plots (fig. 1).

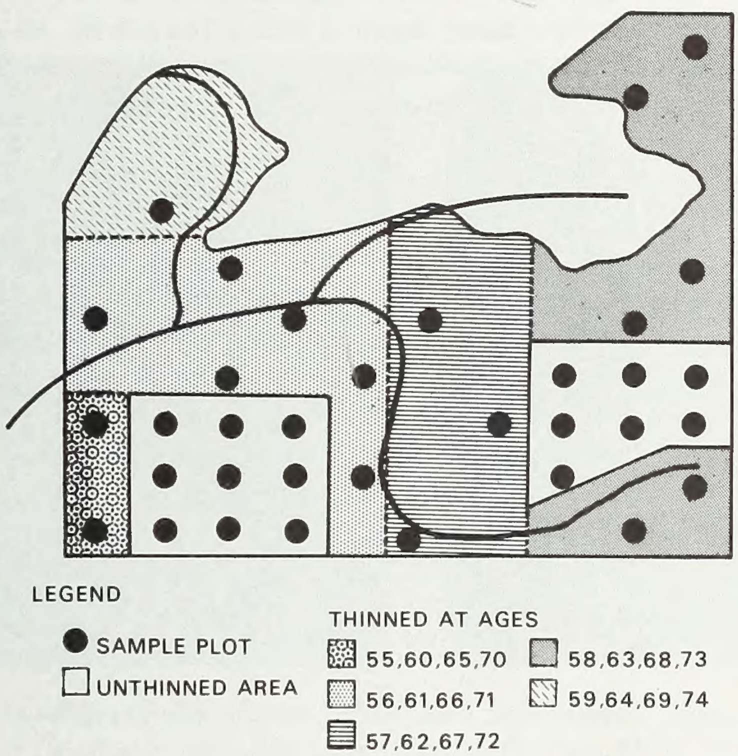

Figure 1.--Layout of thinning units and sample plots within Douglas-fir portion of McCleary Experimental Forest.

1/ *Maintained by the Pacific Northwest Forest and Range Experiment Station in cooperation with Simpson Timber Company.*

2/ *Other portions of the Experimental Forest fall largely outside the Douglas-fir type and are excluded from consideration in this paper.*

MEASUREMENTS

Diameters (d.b.h.) of all tagged trees were measured on each plot at approximately 5-year intervals, coincident with the thinning cycle. In some instances, measurements were made during the growing season, thus resulting in fractional numbers of years between measurements. Heights of a few of these trees, on selected plots, were measured at less frequent intervals. At age 76, heights of at least five trees on each plot were measured, and ages of two dominant trees per plot were determined.

ESTIMATION OF VOLUME

Volumes were computed by means of tarif-volume equations.[3/] Tarif access tables[4/] were used to determine tarif numbers of trees measured for height, and tarif numbers at age 76 were thus assigned to plots. Average tarif numbers were 44.4 for the thinned stand and 48.0 for the unthinned stand. For past tarif numbers, an average rate of increase in tarif number of 0.3 per year, based on trees which had also been measured previously for height, was assigned to all plots. By applying these to tarif-volume equations, local volume tables were derived for each plot for each measurement year, thus allowing estimation of past volume and volume growth. There is some evidence that the real rate of increase in tarif number may have been a little less with thinning than without thinning. If so, we have underestimated initial volume and overestimated volume growth of thinned stands relative to unthinned stands.

PRESENTATION OF DATA

For simplicity of presentation, data for the subareas have been averaged for thinned and unthinned stands. Since measurements and thinnings were staggered in time and subareas were sampled by variable numbers of plots, all averages (including number of years in growth period) are weighted by number of plots in each subarea. Thinned stand ages given are plus or minus 2 years; most are within 1 year. The average ages at time of measurements in thinned and unthinned stands do not coincide, but we believe they are sufficient for reasonable comparisons.

3/ *K. J. Turnbull and G. E. Hoyer. Construction and analysis of comprehensive tree-volume tarif tables. State Wash. Dep. Nat. Resour. Manage. Rep. 8, 63 p., 1965.*

Tarif-volume equations provide a series of harmonized volume/d.b.h. curves, each indexed by a tarif number. The tarif number is the cubic volume (from stump to 4-inch top) for a tree of 1.0 square foot of basal area.

4/ *Gerald E. Hoyer. Tarif access tables for the Pacific Northwest. State Wash. Dep. Nat. Resour., 1966.*

STUDY AREA

SITE CONDITIONS

The experimental area lies on gentle to medium slopes at elevations of 300 to 600 feet. Both climate and soil favor rapid tree growth. A nearby weather station, at Elma, shows an average annual precipitation of 66 inches, with 14 inches from April through September. Average annual temperature is 51° F.; average from April through September is 58° F. The average frost-free growing season is about 185 days. The soils, which are derived from glacial till with some admixture from underlying basalt, are predominantly Tebo gravelly loam--both normal and wet phases.[5] King's site index[6] on the 34 plots averaged 138 (low Site I) and ranged from 126 to 153.

THE STAND

The stand originated after repeated fires (fig. 2). It is relatively pure Douglas-fir, with a scattering of other species--mostly hemlock and alder. On the average, 95 percent of the volume is Douglas-fir.

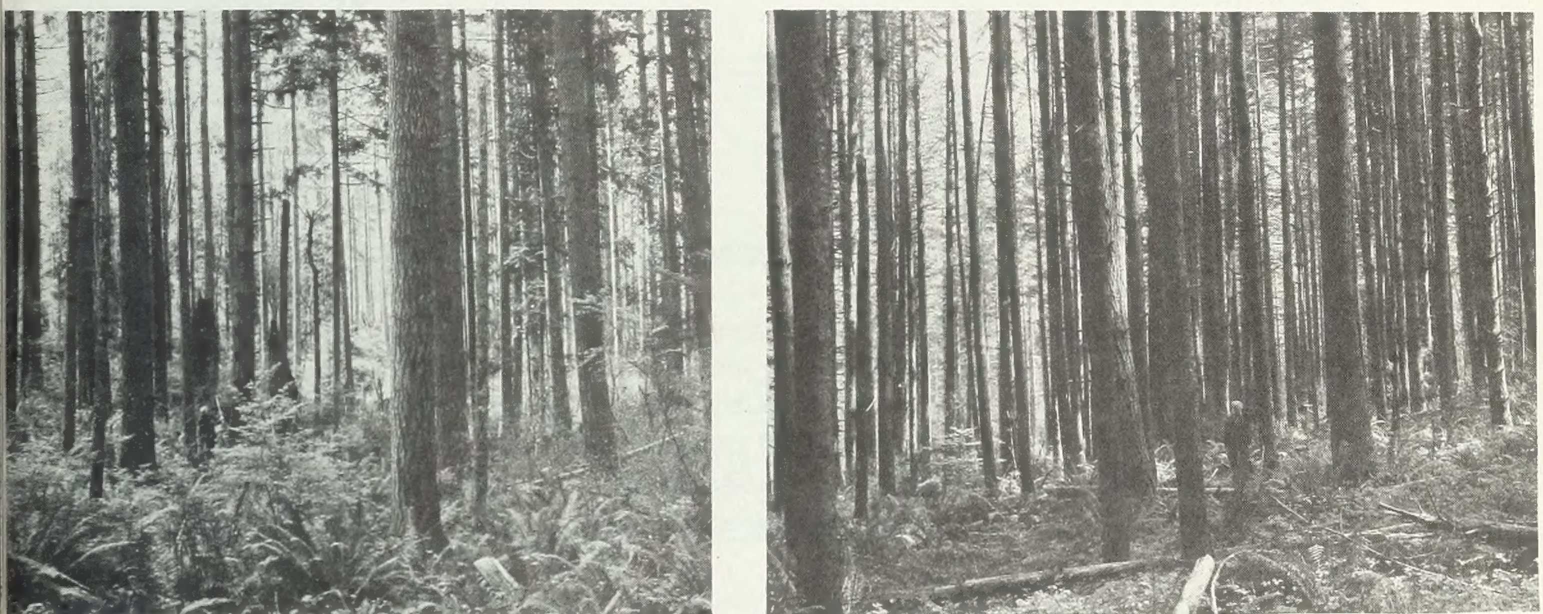

Figure 2.--Photographs of thinned (left) and unthinned (right) stands at age 67. Picture of thinned stand was taken just before the third thinning.

5/ *Carl McMurphy, Soil Conservation Service, Olympia, Wash., personal communication. Soil had previously been classified as Olympic loam.*

6/ *James E. King. Site index curves for Douglas-fir in the Pacific Northwest. Weyerhaeuser For. Res. Pap. 8, 49 p., 1966.*

At age 57, just before initial thinning, the stand contained about 150 stems per acre, with a quadratic mean d. b. h.[7/] of 17. 2 inches. The basal area of the stand averaged 241 square feet per acre, and the total volume averaged 10, 460 cubic feet per acre. Nearly 90 percent of the trees were larger than 9. 5 inches d. b. h. , and these contained about 98 percent of the total basal area and cubic volume.

The stand designated for thinning had slightly fewer and larger trees, 5 percent less basal area, and (as calculated) 15 percent less total cubic volume[8/] than the unthinned stand (table 1).

Table 1.--*Stand characteristics before initial thinning, trees 5.5 inches and larger in d.b.h., per-acre basis*

Item	Unthinned	Thinned	Average
Age.................years	56.9	57.3	57.1
Site index (50)	141	136	138
Stems..............number	157	142	149
Mean d.b.h.........inches	17.0	17.4	17.2
Basal area....square feet	248	235	241
Cubic volume...cubic feet	11,350	9,670	10,460
Percent Douglas-fir	97	94	95

TREATMENT

The areas designated for thinning were each thinned four times, at approximately 5-year intervals. The four thinnings combined removed a total of 50 trees per acre, with a mean d. b. h. of 17. 2 inches. These trees contained 81 square feet of basal area and 3, 420 cubic feet of volume per acre (table 2). In addition to this, thinnings salvaged about two-thirds of the mortality, thus increasing the harvested volume by about 10 percent.

The first thinning was heavier than subsequent thinnings and also removed larger trees. The diameter of cut trees was 10 percent larger than the stand average at the first thinning, whereas it was 15 to 20 percent smaller than stand average at subsequent thinnings.

7/ *Quadratic mean d.b.h. is the diameter at breast height of a tree of mean basal area. Hereafter, mean d.b.h. refers to this quadratic mean.*

8/ *Because of possible errors in estimates of past tarif numbers, as much as half of this apparent difference in initial volume could be an artifact of the method of calculation; the remaining difference is associated with slight differences in site index and stand structure and with incomplete stocking (occupancy) of the area.*

Table 2.--*Characteristics of thinnings (live trees), per-acre basis*[1]

Thinning number	Number of stems	Mean d.b.h.	d/D ratio[2]	Basal area	Total volume
		Inches		*Square feet*	*Cubic feet*
1	15	19.1	1.10	31	1,250
2	14	15.3	.84	18	740
3	12	16.4	.83	18	770
4	8	17.6	.82	14	650
Total	50	17.2	--	81	3,420

1/ Apparent slight discrepancies are due to rounding of numbers.

2/ d = mean d.b.h. of cut trees, D = mean d.b.h. of all trees before thinning.

The first thinning removed 13 percent of the live basal area and cubic volume. Subsequent thinnings each removed less volume than this, averaging about 8 percent of the volume present before each thinning. The volume cut in these latter three thinnings equalled an average of 64 percent of the gross growth accrued between thinnings. Mortality in thinned stands nullified an additional 14 percent of the gross growth, whereas mortality in unthinned stands nullified 26 percent of the gross growth.

Thinnings gradually reduced residual basal area to a minimum of 72 percent of that in a comparable unthinned stand (fig. 3); they reduced residual cubic volume to a minimum of about 75 percent of that in a comparable unthinned stand. After the fourth cut, basal area was 17 percent less than it had been before thinning 15 years earlier; cubic volume was about 5 percent less than it had been before thinning 15 years earlier.

STAND DEVELOPMENT

MORTALITY

Mortality in thinned stands was generally much less than that in unthinned stands (table 3). The unthinned stand lost 27 trees per acre with a mean d.b.h. of 12.1 inches, whereas the thinned stand lost only 17 trees with a mean d.b.h. of 11.6 inches. Thus, 15-year cubic volume loss in the thinned stand was about half that in the unthinned--490 vs. 1,025 cubic feet.

Distribution of mortality over time and over the area were both very erratic. The heaviest mortality in the thinned stand was in the first period. However, this was very strongly weighted by excessive windthrow on only one plot which suffered nearly three times as much volume loss as the maximum in one period on any other plot.

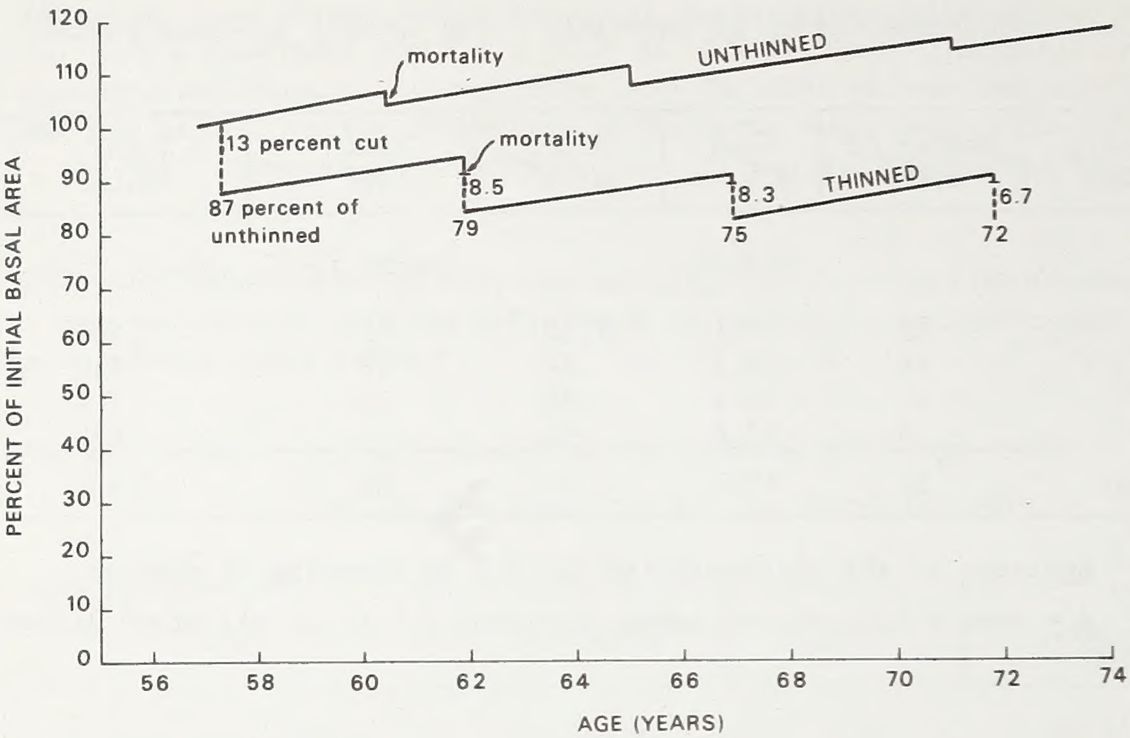

Figure 3.--Relative basal area growth and yield of thinned and unthinned stands.

Table 3.--*Mortality per acre in thinned and unthinned stands, trees 5.5 inches and larger in d.b.h.*[1]

Period	Number of years in period[2]	Number of stems	Mean d.b.h.	Basal area	Total volume
			Inches	*Square feet*	*Cubic feet*
		Unthinned stands			
1	3.5	8	11.9	6	270
2	4.6	13	11.9	10	420
3	6.0	6	13.1	6	330
Total	14.1	27	12.1	22	1,020
		Thinned stands			
1	4.6	9	11.8	7	300
2	5.1	4	10.0	2	80
3	4.9	3	13.0	3	110
Total	14.6	17	11.6	12	490

[1] Apparent slight discrepancies are due to rounding of numbers.

[2] Fractional number of years represent a combination of (1) measurement made during the growing season and (2) averaging of subareas having measurement periods of different lengths.

GROWTH AND YIELD

The 5-year growth period following the fourth thinning was not yet completed on all subareas, so we assessed only the effect of three thinnings on 15-year growth. Our primary interest is in volume. However, since volume estimates are less reliable than basal area estimates, we have also presented the latter to provide a further basis for comparison. Because of substantial within-treatment variation, neither gross nor net increment differed significantly among treatments when data were adjusted to compensate for initial differences in basal area or volume.[9/]

Basal Area

Basal area of growing stock over the 15-year period varied between 194 and 214 square feet per acre in the thinned stand,[10/] whereas it steadily built up from 248 to 281 square feet in the unthinned stand (table 4). With these lower levels of growing stock, the thinned stand grew (gross increment) at an average rate of 3.7 square feet per acre per year, compared with 3.9 square feet in the unthinned stand.

Gross growth during the first two periods was evidently reduced by thinning. When data are adjusted to compensate for initial differences in basal area, we see that reduction in growth for the first period may have been nearly proportional to reduction in growing stock (13 percent). Thereafter, relative growth in the thinned stand improved. For the total 15-year period, average growth in the thinned stand was only 2.5 percent less than in the unthinned stand. The thinned stand now apparently is making as much growth, but with about 75 percent as much growing stock, as a comparable unthinned stand.

Adjusted basal areas of standing live trees at age 72 (15 years after initial thinning) were 201 and 277 square feet in thinned and unthinned stands, respectively--a difference of 76 square feet. This difference has been more than offset by the basal area removed in live thinnings and salvaged mortality, which totals about 88 square feet. Thus, the thinned stand produced about 12 square feet (4.3 percent) more usable basal area to age 72 than did a comparable unthinned stand.

9/ *Data were adjusted by expressing all values for each treatment as a percent of their respective initial pretreatment basal area or volume. To put these on an absolute basis, these percents were multiplied by the average pretreatment basal area or volume.*

10/ *These extremes in amount of growing stock are the minimum and maximum to which observed growth was added. They are, respectively, the minimum residual basal area left after any thinning and the maximum basal area present just before any thinning other than the first.*

Table 4.--*Basal area growth and yield per acre of thinned and unthinned stands, trees 5.5 inches and larger in d.b.h.*[1]

Item	Unthinned			Thinned		
	Age	Basal area	Per annum	Age	Basal area	Per annum
	Years	*--Square*	*feet--*	*Years*	*--Square*	*feet--*
Initial basal area	56.9	248	--	57.3	235	--
Live cut		0	--		31	--
Residual		248	--		205	--
Increment[2]		15	4.2		17	3.6
Mortality		6	1.9		7	1.6
Live basal area	60.4	256	--	61.9	214	--
Live cut		0	--		18	--
Residual		256	--		196	--
Increment[2]		18	3.9		18	3.5
Mortality		10	2.1		2	.5
Live basal area	65.0	264	--	67.0	211	--
Live cut		0	--		18	--
Residual		264	--		194	--
Increment[2]		22	3.7		20	4.0
Mortality		6	.9		3	.6
Live basal area	71.0	281	--	71.9	210	--
Live cut		0	--		14	--
Residual		281	--		196	--
Totals:						
Increment[2]		55	3.9		54	3.7
Mortality		22	1.5		12	.8
Live cut		0	--		81	--

1/ Apparent slight discrepancies are due to rounding of numbers.

2/ Gross increment; the difference between starting and ending basal area of trees present at both ends of the period.

Total Cubic Volume

In the thinned stand, total cubic volume of growing stock tended to build up very gradually, varying between 8,430 and 9,810 cubic feet; in the unthinned stand, it built up steadily from 11,350 to 14,200 cubic feet (table 5). Associated with these levels of growing stock, gross increment in the thinned stand averaged 232 cubic feet per acre per year, whereas that in the unthinned stand averaged 275 cubic feet per acre per year.

Table 5.--*Total cubic volume growth and yield per acre of thinned and unthinned stands, trees 5.5 inches and larger in d.b.h.*[1]

Item	Unthinned			Thinned		
	Age	Total volume	Per annum	Age	Total volume	Per annum
	Years	*----Cubic*	*feet---*	*Years*	*---Cubic*	*feet--*
Initial volume	56.9	11,350	--	57.3	9,670	--
Live cut		0	--		1,250	--
Residual		11,350	--		8,430	--
Increment[2]		920	263		1,060	231
Mortality		270	78		300	65
Live volume	60.4	12,000	--	61.9	9,190	--
Live cut		0	--		740	--
Residual		12,000	--		8,450	--
Increment[2]		1,250	271		1,130	222
Mortality		420	92		80	16
Live volume	65.0	12,820	--	67.0	9,490	--
Live cut		0	--		770	--
Residual		12,820	--		8,720	--
Increment[2]		1,710	285		1,200	245
Mortality		330	54		110	23
Live volume	71.0	14,200	--	71.9	9,810	--
Live cut		0	--		650	--
Residual		14,200	--		9,160	--
Totals:						
Increment[2]		3,880	275		3,390	232
Mortality		1,020	73		490	34
Cut		0	--		3,420	--

[1] Apparent slight discrepancies are due to rounding of numbers.

[2] Gross increment; the difference between starting and ending volume of trees present at both ends of the period.

Adjustment of data to compensate for initial differences in volume is dependent upon **assumptions** regarding reasons for these initial differences. As noted previously, it is quite likely that part of the apparent difference is attributable to the method of volume computation.

If we assume that the entire difference in initial volume is real--due to variation in stocking and site quality--then we should adjust all values in proportion to this initial difference. **Based on this assumption,** 15-year cubic-volume growth per acre was virtually equal in thinned and unthinned stands. Through the course of four thinnings, volume in the thinned stand was reduced to about 75 percent of that in a comparable unthinned stand at age 72 (fig. 4). The sum of standing volume at age 72 plus volume removed in thinnings and salvaged mortality would be about 600 cubic feet, or 4.5 percent, greater in the thinned stand than in the unthinned stand.

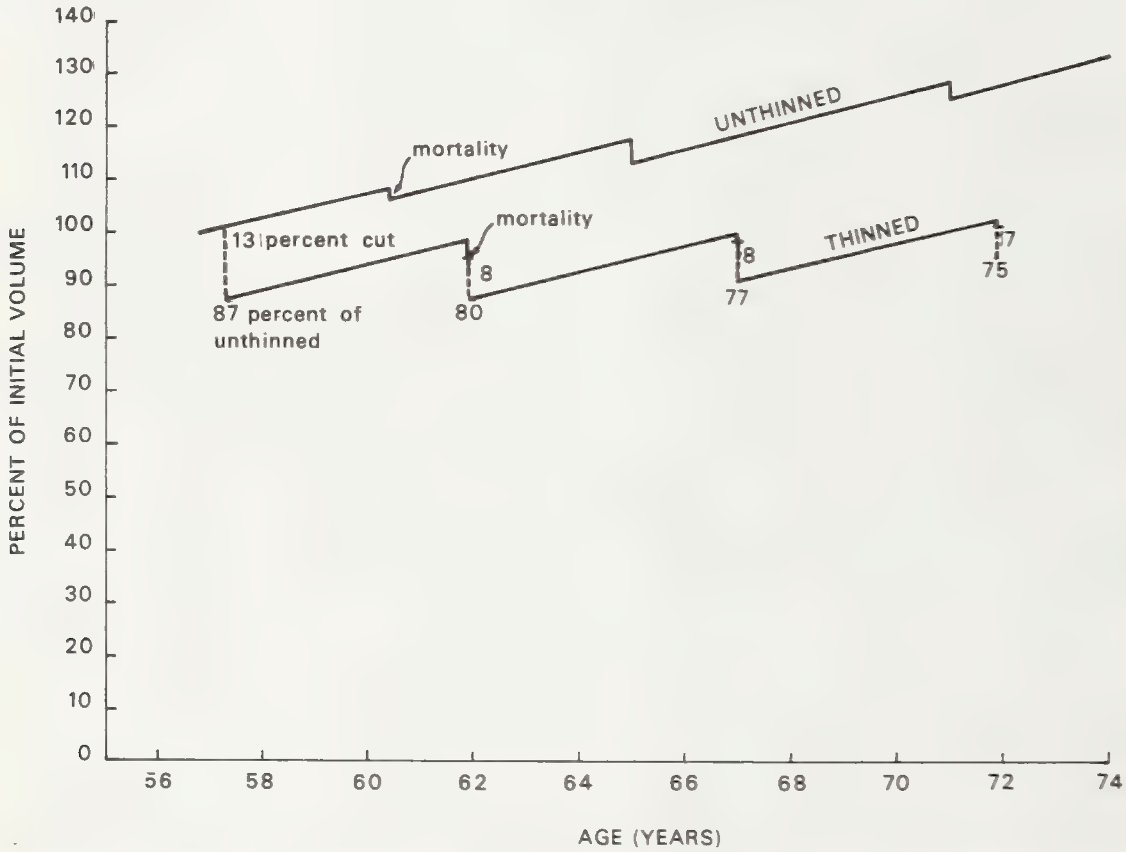

Figure 4.--Relative cubic volume growth and yield in thinned and unthinned stands.

If, on the other hand, we assume that part of the apparent difference in initial volume is due to the assignment of too great a change in tarif number to the thinned stand, then we must correct the thinned-stand values for this before making the above adjustment. **Based on the assumption** that one-quarter of the apparent difference in initial volume was due to this cause, 15-year cubic-volume growth in the thinned stand was 13 percent less than that in a comparable unthinned stand. Adjusted standing live volumes at age 72 were 13,610 and 9,740 cubic feet, respectively, in unthinned and thinned stands. This

difference of 3,870 cubic feet was offset by about 4,120 cubic feet removed in thinnings and salvaged mortality. Thus, the gain from thinning was only 250 cubic feet, or less than 2 percent.

The truth probably lies somewhere between these extremes, and the authors believe gain from thinning was closer to the latter.

Projecting yields to the future, we can expect current differences in standing volume between thinned and unthinned stands to diminish somewhat. Gross growth should be nearly equal in thinned and unthinned stands, whereas mortality should be less in thinned than in unthinned stands. Therefore, the gains in usable volume from thinned stands will increase by an amount equal to the difference between thinned and unthinned stands in volume of salvagable mortality--perhaps as much as 50 cubic feet per year. Thus, if we project 10 years (to age 82), as time of final harvest, the additional gain in volume associated with thinning would be 500 cubic feet. This would mean a total gain over the rotation of about 5 percent.

Merchantable Volume

The results reported for total cubic volume apply virtually as well to merchantable volume (table 6). In the thinned stand, sawtimber volume after four thinnings was nearly equal to that before the first thinning. In the unthinned stand, it increased by about 30 percent over the same period of time. Thus, it is apparent that had the stands been identical before thinning, the **residual** sawtimber volume at age 72 (immediately after the fourth thinning) in the thinned stand would be about 30 percent less than that in the unthinned stand. As with total cubic volume, this difference between thinned and unthinned stands will lessen somewhat by the time of final harvest.

ATTAINED D.B.H. AND D.B.H. GROWTH

At age 72, mean d.b.h.'s in thinned and unthinned stands were 21.8 and 20.0 inches, respectively. Over the preceding 15-year period, mean d.b.h. in thinned stands had increased by 4.4 inches, whereas mean d.b.h. in unthinned stands had increased by 3.0 inches (table 7).

This increase in average d.b.h. reflects the combination of actual growth and immediate changes in d.b.h. due to removal of trees through thinnings and mortality. In examining growth of the trees surviving each period, we find that d.b.h. growth averaged 29 percent greater in thinned than in unthinned stands (table 8). Periodic annual d.b.h. increment was 0.18 inch in thinned stands, compared with 0.14 inch in unthinned stands. This amounts to 2.7 vs. 2.1 inches of d.b.h. growth over a 15-year period.

Table 6.--*Total and merchantable volumes in thinned and unthinned stands, trees 5.5 inches and larger in d.b.h., per-acre basis*[1]

Item	Unthinned stand		Thinned stand	
	Cubic feet	*Thousand board feet*	*Cubic feet*	*Thousand board feet*
Initial stand, age 57:				
Total cubic[2]	11,370	--	9,610	--
Merchantable cubic	10,780	--	9,120	--
International	--	70.9	--	59.0
Scribner	--	60.7	--	51.1
15-year mortality:				
Total cubic	1,020	--	490	--
Merchantable cubic	920	--	430	--
International	--	5.7	--	2.6
Scribner	--	4.5	--	2.1
Live cut:				
Total cubic	--	--	3,420	--
Merchantable cubic	--	--	3,140	--
International	--	--	--	21.1
Scribner	--	--	--	18.2
Ending stand, age 72:				
Total cubic	14,390	--	9,180	--
Merchantable cubic	13,820	--	8,760	--
International	--	92.6	--	59.2
Scribner	--	81.8	--	53.7

[1] Adjusted for slight differences in age to provide comparable 15-year periods; not adjusted for initial differences in volume.

[2] Total cubic is the total volume of the stand. Merchantable cubic, International, and Scribner are volumes to a 6-inch top diameter of trees 7.5 inches and larger in d.b.h.

Table 7.--*Number of trees per acre and mean d.b.h. in thinned and unthinned stands, trees 5.5 inches and larger in d.b.h.*[1/]

Item	Unthinned			Thinned		
	Age	Number of stems	D.b.h.	Age	Number of stems	D.b.h.
	Years		*Inches*	*Years*		*Inches*
Live trees	56.9	157	17.0	57.3	142	17.4
Cut		0	--		15	19.1
Residual		157	17.0		127	17.2
Mortality		8	11.9		9	11.8
Live trees	60.4	149	17.7	61.9	117	18.3
Cut		0	--		14	15.3
Residual		149	17.7		103	18.7
Mortality		13	11.9		4	10.0
Live trees	65.0	136	18.8	67.0	99	19.8
Cut		0	--		12	16.4
Residual		136	18.8		87	20.2
Mortality		6	13.1		3	13.0
Live trees	71.0	130	19.9	71.9	84	21.4
Cut		0	--		8	17.6
Residual		130	19.9		76	21.8
Total mortality		27	12.1		17	11.6
Total cut					50	17.2

[1/] Apparent slight discrepancies are due to rounding of numbers.

Table 8.--*D.b.h. growth of trees surviving each period,*[1/] *trees 5.5 inches and larger in d.b.h.*

Item	Unthinned	Thinned
Period 1:		
Length of period............years	3.5	4.6
Stems......................number	149	117
Starting d.b.h.............inches	17.2	17.6
Periodic annual increment..inches	.15	.16
Period 2:		
Length of period............years	4.6	5.1
Stems......................number	136	99
Starting d.b.h.............inches	18.2	19.0
Periodic annual increment..inches	.14	.17
Period 3:		
Length of period............years	6.0	4.9
Stems......................number	130	84
Starting d.b.h.............inches	19.1	20.4
Periodic annual increment..inches	.13	.21
Total		
Length of period............years	14.1	14.6
Periodic annual increment..inches	.14	.18

[1/] Trees which died during the period are excluded. Therefore, starting d.b.h.'s do not agree with residual d.b.h.'s shown in table 7.

DISCUSSION AND CONCLUSIONS

Thinnings carried out at McCleary--especially the first--were light by standards currently applied in many parts of the region. On the other hand, some current thinnings are yet lighter.

These thinnings resulted in a slight gain in usable volume. The effect of these thinnings on volume growth per acre is uncertain, but we estimate that they caused about a 10-percent reduction in gross growth over the 15-year period. This was more than offset by forestalling and salvaging mortality, so that the sum of the current standing volume and volume already harvested from the thinned stand is a little greater than the current volume in a comparable unthinned stand. The gain from these past thinnings will continue to increase somewhat between now and the final harvest, because there will be less mortality in thinned than in unthinned stands.

The thinnings resulted in an increased rate of growth of residual trees, but the benefit of this more rapid increase in tree size was largely offset through removal of larger than average trees in the initial thinning. Thus, residual trees are not appreciably larger in the thinned stand than in the unthinned stand. Within the range represented, tree size has very little effect on board-foot:cubic-foot ratios, so sawtimber volumes are nearly proportional to total cubic volumes.

The gain in total usable production due to these thinnings will be only about 5 percent if the stand is harvested 10 years after the last thinning. The primary gain from thinnings has been an earlier harvest of part of the stand, largely at the expense of volume otherwise available for final harvest. The thinned stand will contain about 20 percent less volume per acre at that time than will the unthinned stand. The land manager must assess the economics of his particular situation to decide whether or not this is desirable.

If final harvest is delayed longer, the difference in available volume in thinned and unthinned stands will lessen by an amount approximately equal to the difference in volume of unsalvable mortality.

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1973. Yields with and without repeated commercial thinnings in a high-site-quality Douglas-fir stand. USDA For. Serv. Res. Pap. PNW-155, 15 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

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The mission of the PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION is to provide the knowledge, technology, and alternatives for present and future protection, management, and use of forest, range, and related environments.

Within this overall mission, the Station conducts and stimulates research to facilitate and to accelerate progress toward the following goals:

1. Providing safe and efficient technology for inventory, protection, and use of resources.
2. Development and evaluation of alternative methods and levels of resource management.
3. Achievement of optimum sustained resource productivity consistent with maintaining a high quality forest environment.

The area of research encompasses Oregon, Washington, Alaska, and, in some cases, California, Hawaii, the Western States, and the Nation. Results of the research will be made available promptly. Project headquarters are at:

Fairbanks, Alaska	Portland, Oregon
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P.O. Box 3141
Portland, Oregon 97208

The FOREST SERVICE of the U. S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.